耶鲁大学-南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

Temporal variations and influencing factors of atmospheric CO_2 concentration in Meiliang Bay of Lake Taihu

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Major: Applied Meteorology

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CONTENTS

1 Significance & Purposes

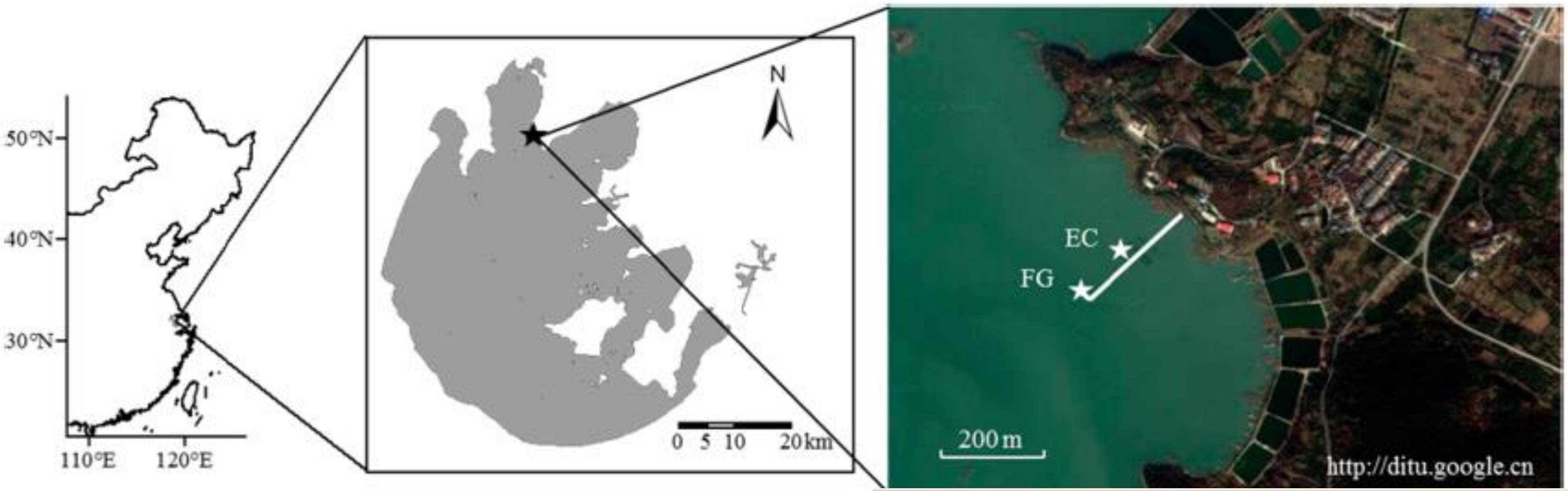
- Atmospheric CO_2 concentration has increased by nearly 50% in less than 300 years (zhang et al.,2010).
- Inland lakes are important components in greenhouse gas cycling.
- Subject to observation techniques, there is less researches on inland lakes. Previous researches, with manual measurements leave much to be desired (Ji et al. 2006).
- Researches on Meiliang Bay (MLW) of Lake Taihu promote the understanding of gas exchange at lake-air interface.

1 Significance & Purposes

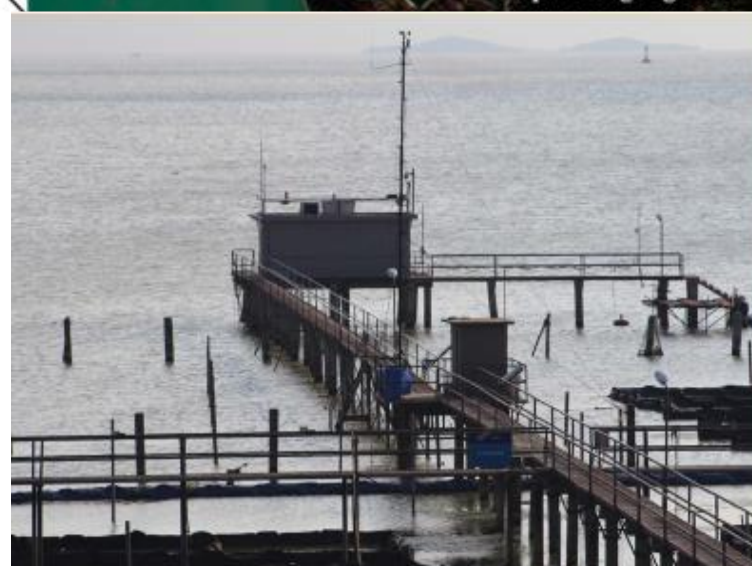
Investigate the temporal variations in atmospheric CO_2 concentration and the main influencing factors at MLW site.

2 Materials & Methods

2.1 Site description



（xaio et al., 2014）



2 Materials & Methods

Which one ?

2.2 Data collection

Atmospheric CO_2 concentration: *WS-CRDS* & *NDIR*

T_a and RH: an air temperature and humidity probe
(model HMP155A; Vaisala, Inc., Helsinki, Finland)

Radiation(DSR, L_u, L_d): a four-way net radiometer
(model CNR4, Kipp & Zonen B. V., Delft, the Netherlands)

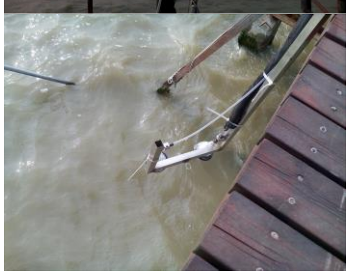
Wind direction: a sonic anemometer/thermometer
(model CSAT3, Campbell Scientific Inc., Logan, Utah)

Precipitation: Wuxi station (120.19E，31.35N)

$$T_W = \left(\frac{L_u - (1-\varepsilon)L_d}{\varepsilon\sigma}\right)^{\frac{1}{4}} \quad VPD = 0.611(1 - RH) * e^{\frac{17.502T_a}{T_a + 240.97}}$$

2 Materials & Methods

2.2 Data collection



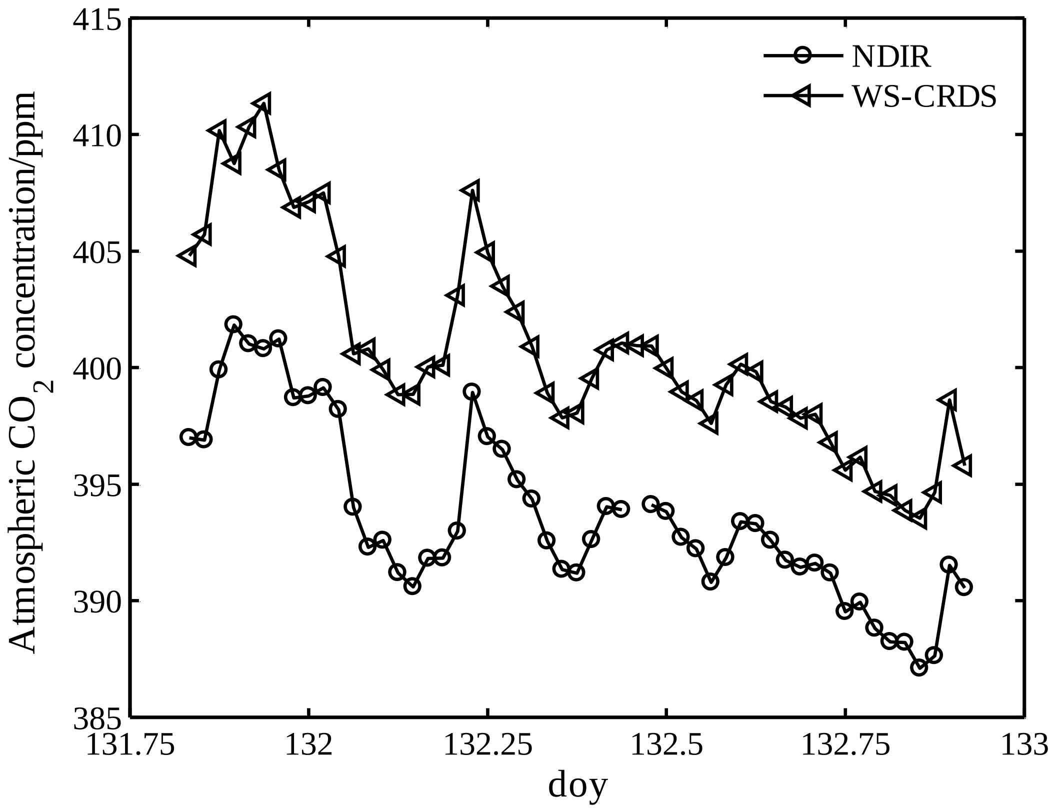
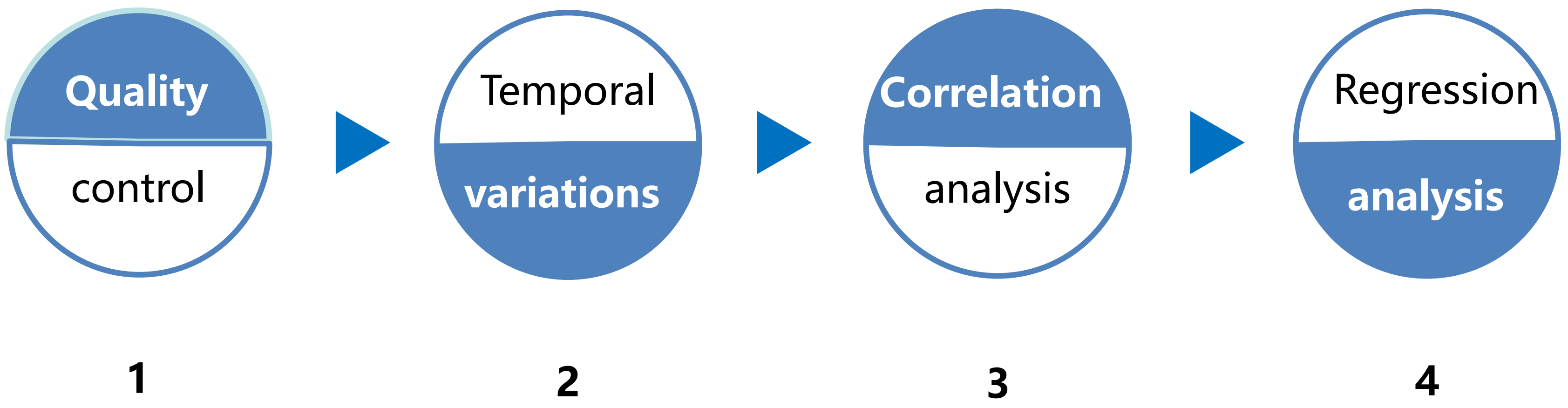


Fig. 1. Comparison between WS-CRDS and NDIR (11-12May 2015)when the wind came from the open water (wind direction 180–270°).(xiao et al., 2014)

2 Materials & Methods

2.3 Method



3 Results & Dicussion

3.1.1 Diurnal variation

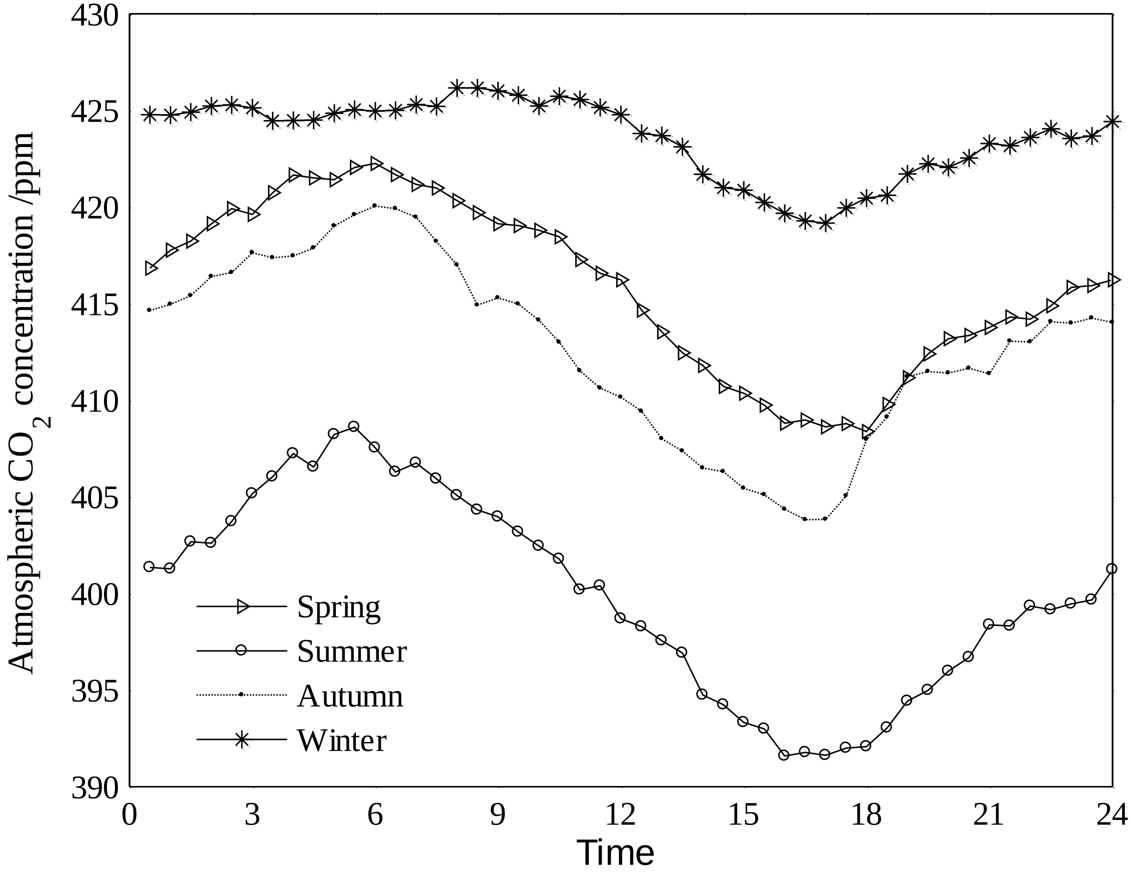


Fig. 2. Diurnal varations of atmospheric CO_2 concentration at MLW (Dec 2012-Nov 2015)

3 Results & Dicussion

3.1.1 Diurnal variation

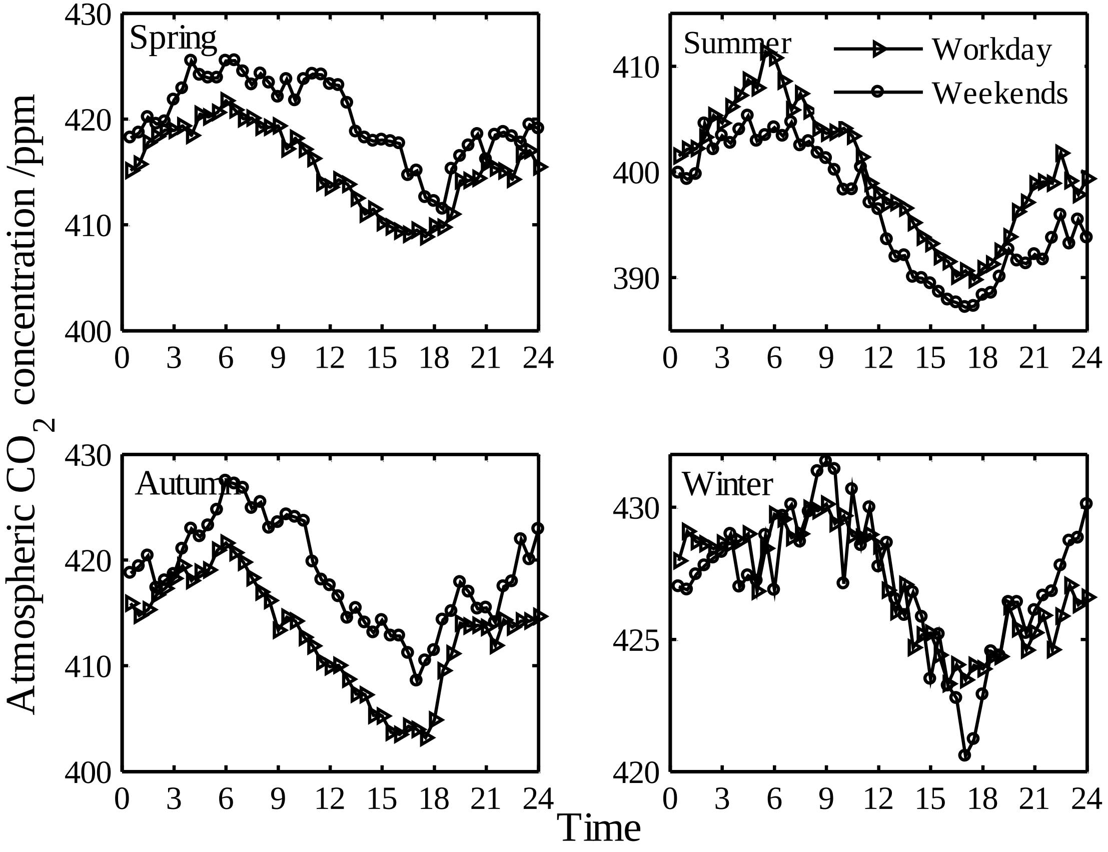


Fig. 3. Different diurnal varations of atmospheric CO_2 concentration on workday and weekends at MLW (2015)

3 Results & Dicussion

3.1.1 Diurnal variation

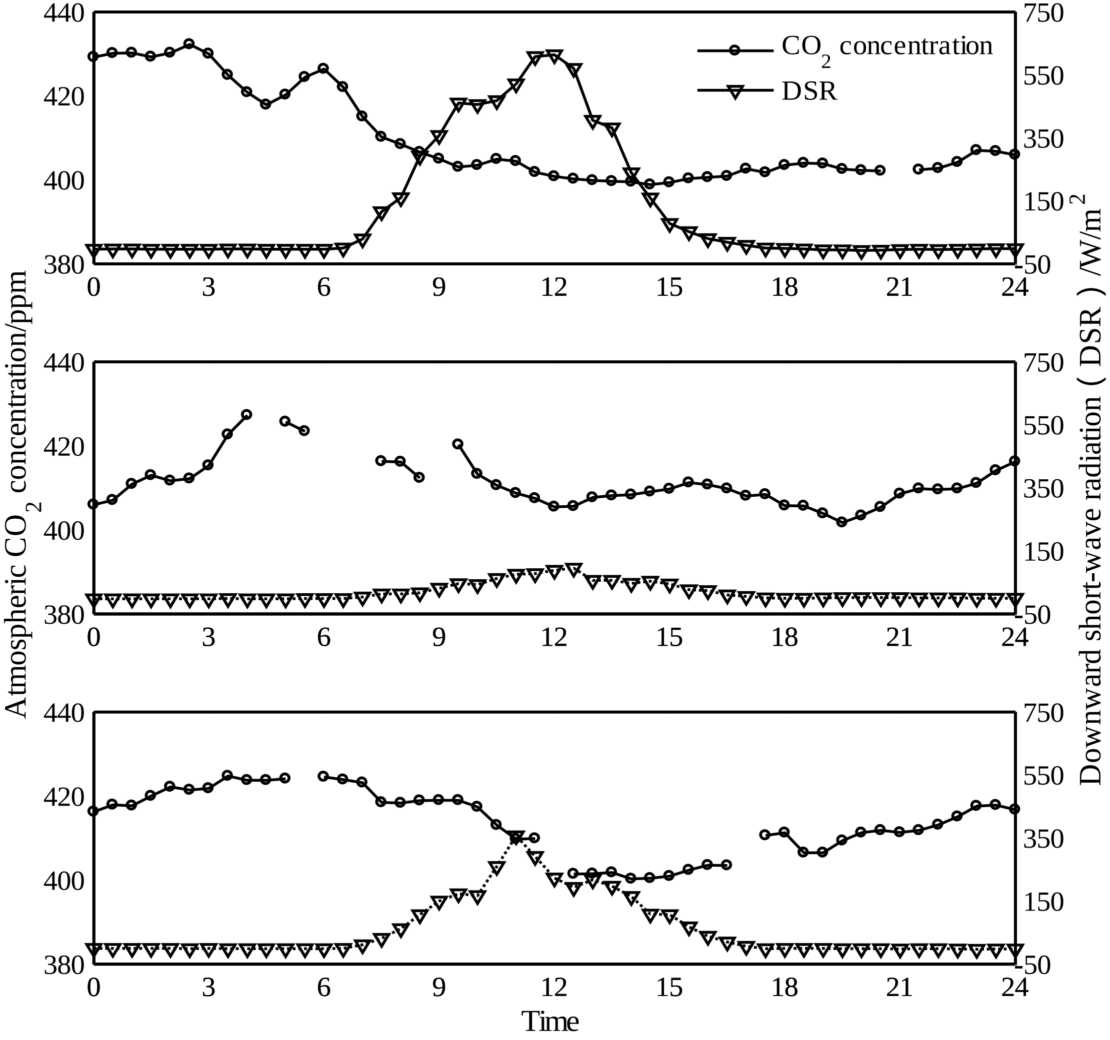


Fig. 4. Different diurnal varations of atmospheric CO_2 concentration before and after a precipitation event at MLW (three days in Nov 2014)

3 Results & Dicussion

3.1.2 Seasonal variation

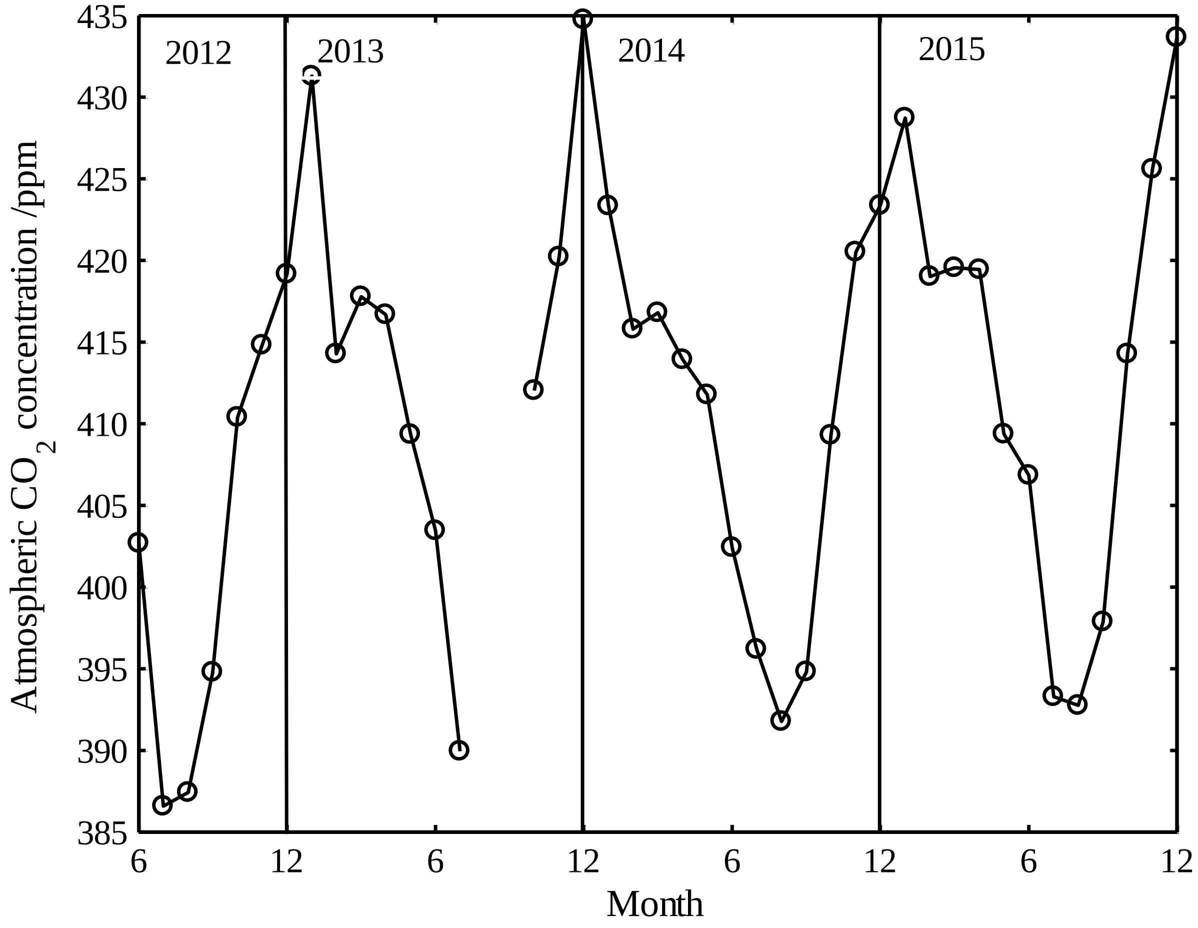


Fig. 5. Diurnal varations of atmospheric CO_2 concentration at MLW (Jun 2012-Dec 2015)

3 Results & Dicussion

3.1.3 Interannual variation

Table 1. Interannual variation in valleys, peaks and averages (2013-2015)

Year	Valley value（ppm）	Peak value（ppm）	Annual average（ppm）
2013	—	434.75	414.98±12.89
2014	391.77	423.36	410.00±11.19
2015	392.76	433.66	413.37±13.59
Average	392.26	430.59	412.66±12.37

—. Missing records

0.082%

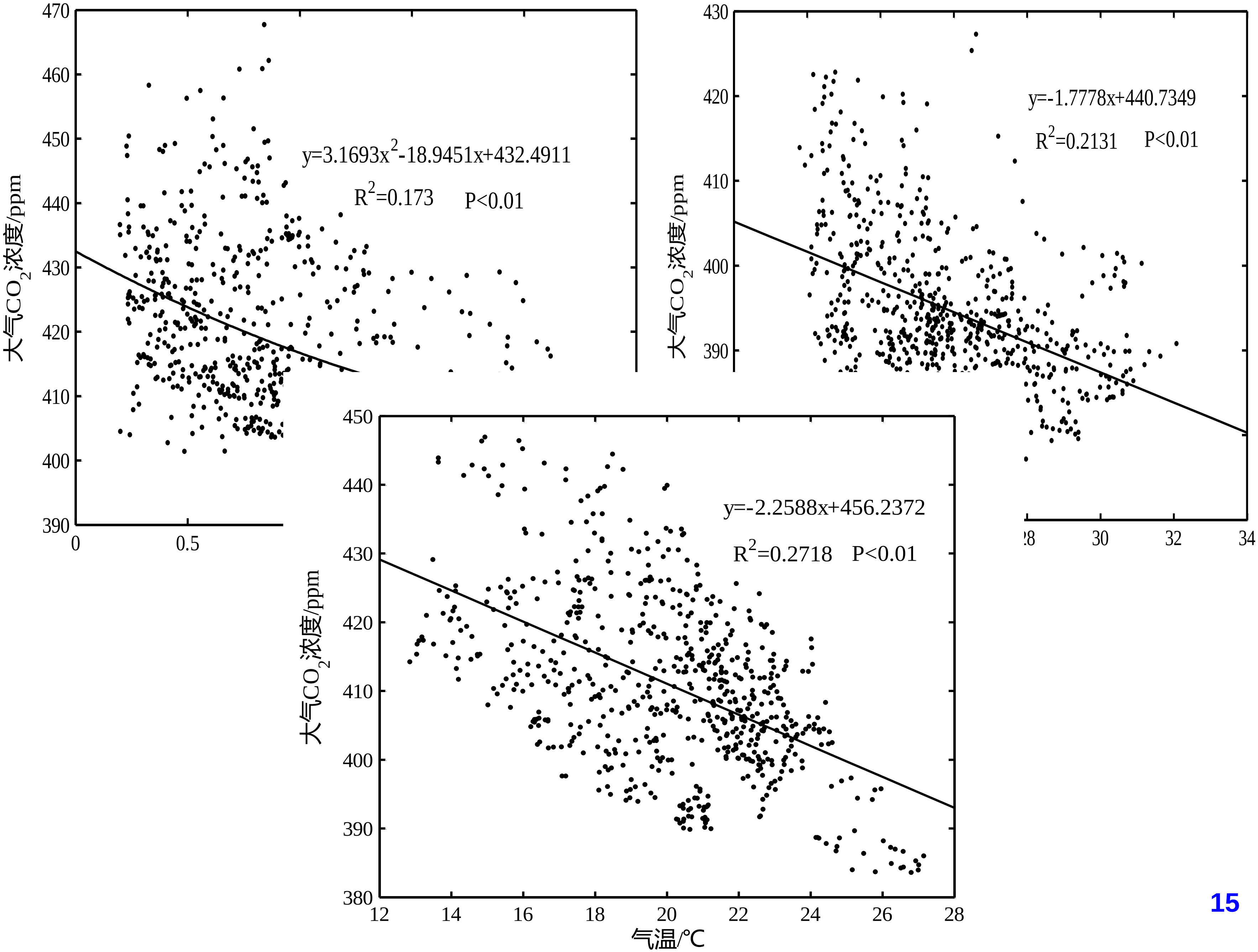
3 Results & Dicussion

3.2.1 Main meteorological influencing factors on semi- hour time scale

Table 2. Correlation coefficients between part of meteorological factors and atmospheric CO_2 concentration on semi- hour time scale

	T_a (℃)		T_w （℃）		DSR (w/m^2)	VPD （kPa）		数据量	
	Day	Night	Day	Night	Day	Day	Night	Day	Night
Spring	-0.277**	-0.118**	-0.267**	-0.129**	-0.138**	-0.42**	-0.246**	2215	1455
Summer	-0.289**	-0.149**	-0.255**	-0.141**	-0.162**	-0.382**	-0.282**	2125	1073
Autumn	-0.682**	-0.547**	-0.711**	-0.573**	-0.272**	-0.628**	-0.519**	1983	1824
Winter	0.115**	0.191**	0.047*	0.067**	0.006	-0.174**	-0.057*	2015	2036

**.Significant correlation on 0.01 level (double side),*.Significant correlation on 0.05 level (double side)



y=3.1693x2-18.9451x+432.4911
R2=0.173 P<0.01
大气CO2浓度/ppm
470
460
450
440
430
420
410
400
390
0
0.5
y=-1.7778x+440.7349
R2=0.2131 P<0.01
大气CO2浓度/ppm
430
420
410
400
390
30
32
34
y=-2.2588x+456.2372
R2=0.2718 P<0.01
大气CO2浓度/ppm
450
440
430
420
410
400
390
380
12
14
16
18
20
22
24
26
28
气温/℃

3 Results & Dicussion

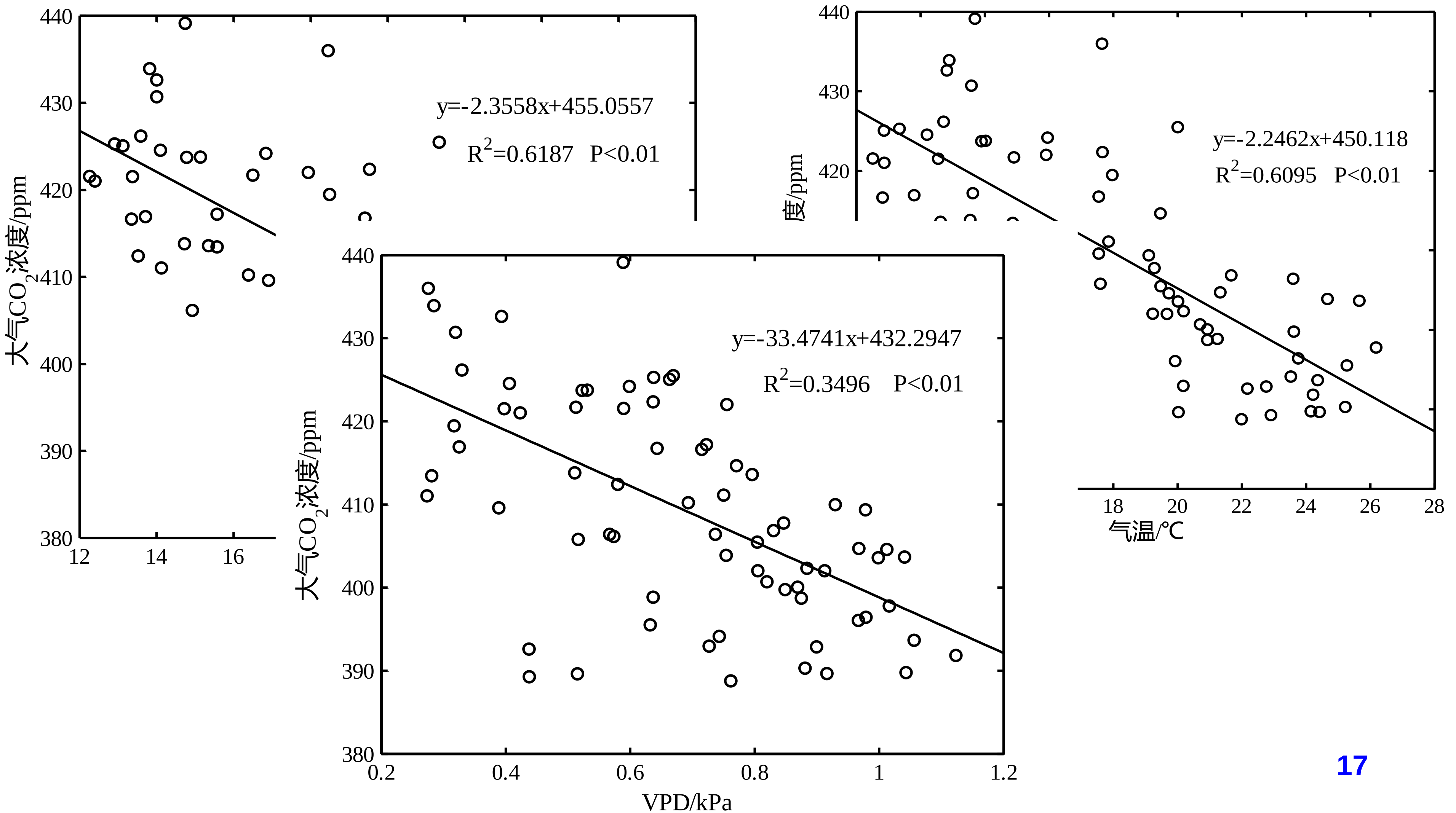
3.2.2 Main meteorological influencing factors on day time scale

Table 3. Correlation coefficients between part of meteorological factors and atmospheric CO_2 concentration on semi- hour time scale[b]

		T_a (℃)	T_W (℃)	DSR (w/m^2)	VPD (kPa)	P (mm)
Spring	C_{aw} (ppm)	-0.102	-0.061	-0.025	-0.221	0.023
Summer		-0.343*	-0.333*	0.199	-0.211	0.117
Autumn		-0.787**	-0.781**	-0.230	-0.591**	-0.015
Winter		0.252*	0.317**	-0.054	0.094	-0.318**

**.Significant correlation on 0.01 level (double side),*.Significant correlation on 0.05 level (double side)
b. Spring N=62, Summer N=42, Autumn N=71, Winter N=87

3 Results & Dicussion



3 Results & Dicussion

3.2.3 Main meteorological influencing factors on month time scale

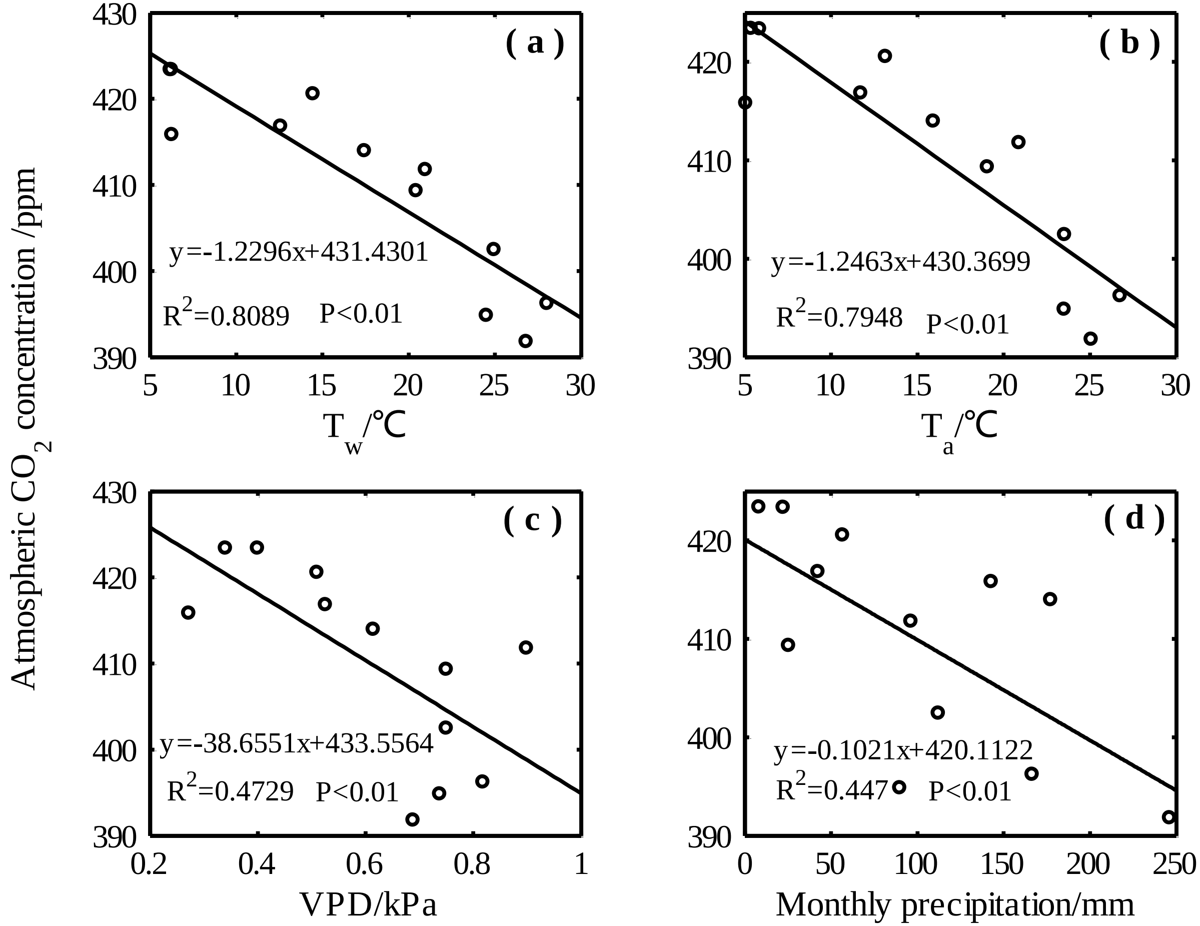


Fig. 11. Regression analysis between part of meteorological factors and atmospheric CO_2 concentration on month time scale

3 Results & Dicussion

3.2.4 Influences of CO_2 flux at lake-air interface

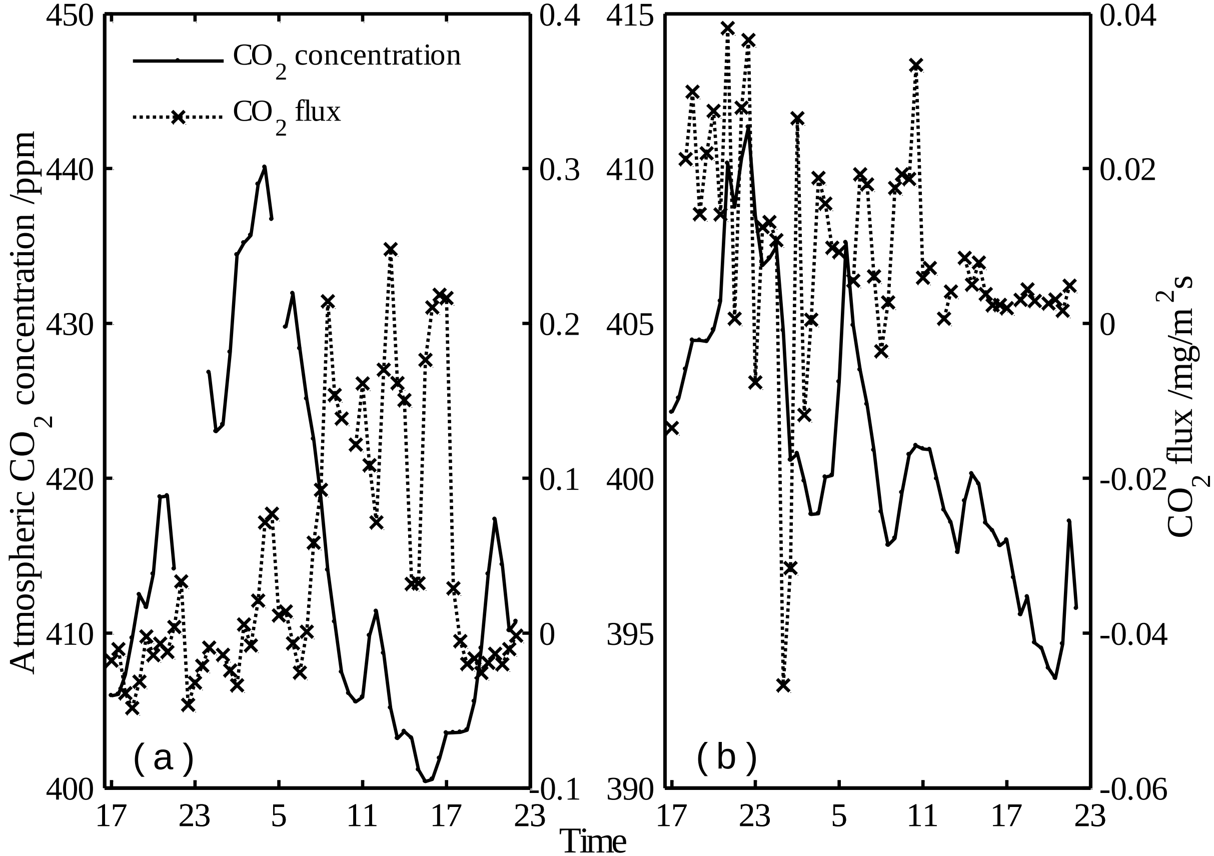


Fig. 11. Analysis of the influences of CO_2 flux at lake-air interface on MLW atmospheric CO_2 concentration under different conditions of wind direction ((a) wind fron inland, (b)wind from lake)

4 Conclusions

The results had shown in the observation time that :

(1) diurnal changes in MLW presented typical sinusoidal curves, the peak appeared at 5:30-8:30, which was largest in winter (426.17ppm), smallest in summer (408.60ppm), the valley appeared at 16:30-18:00, which was largest in winter (419.16ppm), smallest in summer (391.62ppm), daily amplitude variations were largest in summer and autumn, which were 16.98 ppm and 16.24 ppm, next to spring, which was 13.88 ppm, and smallest in winter, which was 7.01 ppm; Moreover, on weekdays and weekends, atmospheric CO_2 concentration had different diurnal changes, as were the same cases on rainy, cloudy and sunny days;

(2) Minimum of MLW atmospheric CO_2 concentration appeared in July or August in summer, fluctuating around 392.26 ppm, then gradually increased to highest in December or January in winter, which was around 430.59 ppm and reduced in spring again;

(3) MLW atmospheric CO_2 concentration had a 0.082% increase from 2014 to 2015.

4 Conclusions

(4) On the semi-hour and day time scales, the main factors influencing MLW atmosphere CO_2 concentration were water temperature, air temperature and VPD, and they had different coeffcients as season changes; The impacts of downward short-wave radiation on concentration on day time scales were weak, rainfall at the monthly time scales had a significant negative correlation;

(5) In addition to the factors mentioned above, the fluxes above Lake-Air interface were weakly correlated to atmospheric CO_2 concentration, and the extent of impacts from lake were less than that from the land.

5 Innovation & Shortages

1. WS-CRDS

2. Microclimatic observation system

3. Study area

5 Innovation & Shortages

1. Ignorance of water quality factors

2. Low usage in data

Thanks for your listening!